TREE HOLE *CULICOIDES* (DIPTERA: CERATOPOGONIDAE) OF THE CENTRAL PLAINS IN THE UNITED STATES

LARRY G. PAPPAS, STEVE MOYER AND CAROL D. PAPPAS

Science and Technology, Peru State College, Peru, NE 68421

ABSTRACT. Three-hundred eleven tree holes were sampled for *Culicoides* at 27 localities in Colorado, Kansas, Nebraska, Oklahoma and South Dakota. Of the 311 samples taken, 170 produced specimens, and 2,899 *Culicoides* were collected including 12 species. The 5 most common species (number collected) were *C. guttipennis* (1,468), *C. arboricola* (355), *C. paraensis* (292), *C. elemae* (186) and *C. footei* (159). Other species collected were *C. villosipennis*, *C. nanus*, *C. hinmani*, *C. oklahomensis*, *C. snowi*, *C. lahillei* and *C. byersi*. New state records include *C. byersi* and *C. arboricola* for Colorado; *C. arboricola* for Wyoming; and *C. lahillei*, *C. elemae*, *C. nanus* and *C. paraensis* for Oklahoma. *Culicoides byersi*, whose larval habitat was previously unknown, was reared from a cottonwood tree hole.

INTRODUCTION

Tree hole *Culicoides* (Diptera: Ceratopogonidae) have been collected through limited light trap and tree hole sampling studies in portions of Colorado (James 1943), Nebraska (Pappas and Pappas 1989) and Oklahoma (Khalaf 1952, 1957). Other collections have been summarized by Blanton and Wirth (1979). Because most previous collections utilized light traps, many species not readily attracted to lights may have been missed. Additionally, there has been little published on the habitats of those species which occupy the Central Plains of the United States.

MATERIALS AND METHODS

Tree holes (311 total) were sampled at 27 localities in Colorado, Kansas, Nebraska, Oklahoma, South Dakota and Wyoming (Fig. 1) during April–June, 1989. Standing water and/or moist organic matter were removed from tree holes and placed in styrofoam cups and covered with glass lids to prevent the escape of adults. The original dampness of the samples was maintained by the periodic addition of distilled water. Emergent adults were collected on a daily basis during the 4 months that samples were kept in the laboratory. Following emergence, adults and associated pupae were mounted on slides (Wirth and Marston 1968) for identification (Blanton and Wirth 1979, Wirth et al. 1985). The species collected in this study are maintained in the Peru State College *Culicoides* collection.

Samples were collected from the following counties of each state (Fig. 1): Bent and Arapaho (Colorado); Finney and Trego (Kansas); Platte and Converse (Wyoming); Osage and Cherokee (Oklahoma); Custer and Fall River (South Dakota); Nemaha (eastern Nebraska); Brown and Keya Paha (northcentral Nebraska); Gosper, Frontier and Harlan (southcentral Nebraska); Howard County (central Nebraska); Burt, Madison and Dixon (northeastern Nebraska); Garden, Keith, Scotts Bluff, Morrill and Dawes (western Nebraska).

RESULTS

Of the 311 total tree holes sampled (21 tree species), 170 produced *Culicoides*. The most commonly collected species was *Culicoides guttipennis* (Coq.) (1,468 specimens); followed by *Culicoides arboricola* Root and Hoffman (355), *Culicoides paraensis* (Goeldi) (292), *Culicoides elemae* Pappas and Pappas (186), *Culicoides footei* Wirth and Jones (159), *Culicoides nanus*

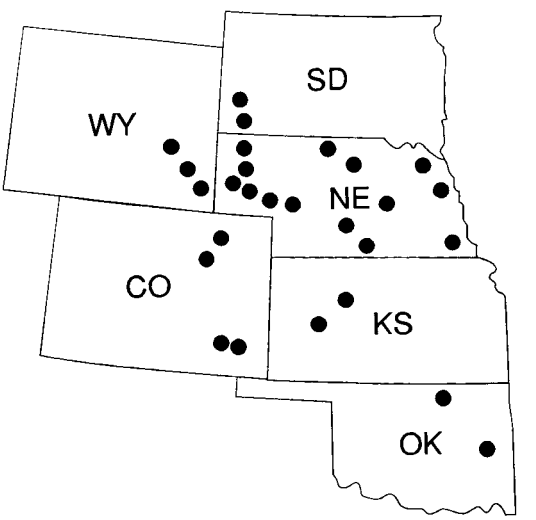

Fig. 1. Collection sites of tree hole *Culicoides* in Colorado (CO), Kansas (KS), Nebraska (NE), Oklahoma (OK), South Dakota (SD) and Wyoming (WY).

Table 1. Number of each species collected from the different tree species in eastern Colorado, western Kansas and Wyoming.

Tree	*n*	*n* wet	Number of specimens V	A	B
Cottonwood	11	4	4	54	1
Red elm	4	1	—	7	—
Total	15	5	4	61	1

n = number of tree holes producing *Culicoides*, *n* wet = number of tree holes which contained standing water. Those species (abbreviations) collected in this region were *C. villosipennis* (V), *C. arboricola* (A) and *C. byersi* (B).

Root and Hoffman (147), *Culicoides hinmani* Khalaf (94), *Culicoides villosipennis* Root and Hoffman (87), *Culicoides oklahomensis* Khalaf (72), *Culicoides snowi* Wirth and Jones (37), *Culicoides lahillei* (Iches) (1), and *Culicoides byersi* Atchley (1).

Wyoming, Colorado and Western Kansas produced the fewest number of species and specimens (Table 1), and the lowest limited diversity of tree species. *Culicoides guttipennis* was collected only in Kansas, while *C. arboricola* was collected in Kansas, Colorado and Wyoming (only species collected in this state). The larval habitat of *C. byersi* was previously unknown (Atchley 1967). This species was collected from a single cottonwood tree hole in Colorado. No *Culicoides* were recovered from the tree holes sampled in western South Dakota.

Eight species of trees produced *Culicoides* at the 2 Oklahoma sites (Table 2) with post oak, winged elm and persimmon producing most of the specimens (284/311). Oklahoma was the only state where *C. oklahomensis* was taken, and is the third most common (72 specimens) species in Oklahoma, along with *C. guttipennis* (98) and

Table 2. Number of each species collected from the different tree species in Oklahoma.

Tree	*n*	*n* wet	Number of specimens G	V	A	O	P	L	F	H	E
Black locust	1	0	—	—	1	—	—	—	—	—	—
Black walnut	1	0	1	—	—	—	—	—	—	—	—
Chinkapin oak	1	1	—	—	—	1	—	—	—	—	—
Pecan	1	1	12	—	3	—	—	—	—	—	1
Persimmon	1	0	2	3	4	3	8	—	27	2	—
Post oak	5	0	26	—	78	66	4	—	4	2	2
Soapberry	1	0	—	—	—	—	—	—	—	—	1
Winged elm	3	2	57	1	—	2	—	1	—	—	—
Total	14	4	98	4	86	72	12	1	31	4	4

n = number of tree holes producing *Culicoides*, *n* wet = number of tree holes which contained standing water. Those species (abbreviations) collected in this region were *C. guttipennis* (G), *C. villosipennis* (V), *C. arboricola* (A), *C. oklahomensis* (O), *C. paraensis* (P), *C. lahillei* (L), *C. footei* (F), *C. hinmani* (H) and *C. elemae* (E).

Table 3. Number of each species collected from different tree species in southeastern Nebraska (Nemaha Co.).

Tree	*n*	*n* wet	Number of specimens G	V	A	P	N	F	H	E
Chinkapin oak	19	19	219	27	—	—	—	—	—	—
Bur oak	1	1	6	7	—	—	—	—	—	—
Red oak	12	9	148	18	1	3	—	—	—	—
Green ash	6	5	52	2	—	1	—	—	—	—
Hackberry	1	1	9	—	—	—	—	—	—	—
Linden	4	1	4	—	—	13	1	1	9	—
Red elm	2	2	18	4	—	—	—	—	—	—
Catalpa	1	1	1	—	—	—	—	—	—	—
Shagbark hickory	1	1	6	—	—	—	—	—	—	—
Bitternut hickory	1	0	—	—	1	—	—	—	—	1
Total	48	40	463	58	2	17	1	1	9	1

n = number of tree holes producing *Culicoides*, *n* wet = number of tree holes which contained standing water. Those species (abbreviations) collected in this region are *C. guttipennis* (G), *C. villosipennis* (V), *C. arboricola* (A), *C. paraensis* (P), *C. nanus* (N), *C. footei* (F), *C. hinmani* (H) and *C. elemae* (E).

Table 4. Number of each species collected from different tree species in Nebraska.

Tree	*n*	*n* wet	Number of specimens								
			G	V	A	S	P	N	F	H	E
Northcentral Nebraska											
Boxelder	15	4	32	—	4	36	11	58	156	80	73
Bur oak	8	6	388	30	—	—	2	—	—	—	12
Cottonwood	3	1	67	—	2	—	1	12	1	—	22
American elm	8	5	45	4	—	—	3	4	—	1	4
Hackberry	1	1	7	—	—	—	—	—	—	—	1
Linden	1	1	28	8	—	—	—	—	—	—	—
Central Nebraska											
Cottonwood	6	0	20	—	—	—	48	1	—	—	7
Green ash	1	0	2	—	—	1	106	—	—	—	1
Red bud	1	1	—	—	—	—	1	—	—	—	4
Southcentral Nebraska											
Cottonwood	20	14	220	—	56	—	65	34	—	—	36
Boxelder	1	0	—	—	—	—	—	—	—	—	1
Western Nebraska											
Cottonwood	14	9	27	—	135	—	—	5	1	—	14
American elm	1	0	1	—	—	—	—	—	—	—	—
Northeast Nebraska											
Boxelder	1	0	—	—	—	—	—	—	—	—	1
Bur oak	7	3	66	—	—	—	—	1	—	—	—
Cottonwood	3	0	1	—	9	—	26	—	—	—	5
American elm	1	1	1	—	—	—	—	—	—	—	—
Total	92	46	905	42	206	37	263	115	158	81	181

n = number of tree holes producing *Culicoides*, *n* wet = number of tree holes which contained standing water. Those species (abbreviations) collected in these regions were *C. guttipennis* (G), *C. villosipennis* (V), *C. arboricola* (A), *C. snowi* (S), *C. paraensis* (P), *C. nanus* (N), *C. footei* (F), *C. hinmani* (H) and *C. elemae* (E).

C. arboricola (86). Most tree holes in Oklahoma (78%) contained moist organic matter but no standing water.

The Nebraska sampling sites represented most of the tree holes producing *Culicoides* (85), the most specimens (1,625) and the largest number of species (9). These data are presented by geographic region in Tables 3 and 4. The tree species producing *Culicoides* in southeastern Nebraska are an extension of the eastern deciduous forest which is dominated by oaks (bur, black, chinkapin, red) (Table 3). These trees usually had tree holes that contained standing water (71% of total) and produced mostly *C. guttipennis* (87% of collected specimens). Other *Culicoides* were collected infrequently and included *C. villosipennis* (37 specimens), *C. paraensis*, (17), *C. arboricola* (1 specimen), *C. nanus* (1), *C. footei* (1), *C. hinmani* (9), *C. elemae* (1).

Data from other sites in Nebraska, by geographic location, are found in Table 4. The tree species in these localities are dominated by elements of the western floodplain forest. Forty-six of the 92 trees having active tree holes were cottonwoods, followed by boxelder (17), bur oak (15) and American elm (10). The bur oak is the only species of *Quercus* which extends into northern and western Nebraska. The locations including samples from northcentral and southcentral Nebraska were dominated by *C. guttipennis*, while other localities had a mixture of species. The northcentral locations shown in Table 4 have the largest number of species (9) of any location examined, and the highest number of specimens for several species. The percentages for each species relative to the total collected for that species in this study are *C. guttipennis* (39%), *C. villosipennis* (48%), *C. arboricola* (2%), *C. snowi* (97%), *C. paraensis* (6%), *C. nanus* (50%), *C. footei* (99%), *C. hinmani* (86%) and *C. elemae* (60%). This large number of species and proportions were collected from 36 tree holes (21% of active tree holes in study). The number of *C. paraensis* at this location is low, however, if the localities of northcentral, central and southcentral Nebraska are combined this species accounts for 49% of the specimens collected in the entire study.

DISCUSSION

Culicoides guttipennis was the most commonly collected species in the Central Plains at most locations except for Colorado and Wyoming, where it was not taken. This species usually inhabits tree holes having standing water along with *C. arboricola* and *C. villosipennis* (Kruger et al. 1990). In Colorado and Wyoming, *C. gut-*

tipennis was replaced by *C. arboricola* in prominence. *Culicoides arboricola* was commonly collected in Oklahoma, western Kansas, Colorado, Wyoming, and the western parts of Nebraska. This species occurred in the same tree holes in Oklahoma with *C. oklahomensis*, which were the only sites where this species was collected. The areas of western Kansas, Colorado and Wyoming produced the fewest number of *Culicoides*, with none being collected at the 2 sites in South Dakota.

Several of the species collected in this study are known to occur primarily in tree holes without standing water (Kruger et al. 1990). These species included *C. paraensis*, *C. nanus*, *C. footei*, *C. hinmani* and *C. elemae*. For the most part, these species were collected from the western regions of Nebraska and associated with tree species such as cottonwood and boxelder.

The present study examined the distribution of tree hole *Culicoides* in the Central Plains. This region contains elements of the southcentral forests such as persimmon, winged elm and post oak; the eastern deciduous forests of southeastern Nebraska dominated by oaks; and the western floodplain forests containing primarily cottonwood, elm and boxelder. To a certain extent, the *Culicoides* species found in these regions are representative of the forest type. The southcentral forests produced *C. oklahomensis*; the eastern deciduous forest of southeastern Nebraska were dominated by *C. guttipennis*; and the western floodplain forest contained large numbers of tree hole species that live primarily in moist tree holes without standing water (i.e., *C. paraensis*, *C. nanus*, *C. footei*, *C. hinmani*, *C. elemae*).

New state records were obtained for *C. lahillei* (Oklahoma), *C. byersi* (Colorado), *C. arboricola* (Colorado and Wyoming), *C. nanus* (Oklahoma), *C. elemae* (Oklahoma) and *C. paraensis* (Oklahoma).

REFERENCES CITED

Atchley, W. R. 1967. The *Culicoides* of New Mexico (Diptera: Ceratopogonidae). Kans. Univ. Sci. Bull. 46:937–1020.

Blanton, F. S. and W. W. Wirth. 1979. Arthropods of Florida and neighboring land areas. Volume 10. The sand flies (*Culicoides*) of Florida. Fla. Dep. Agric. Consumer Serv., Gainesville.

James, M. T. 1943. The genus *Culicoides* in northern Colorado (Diptera, Ceratopogonidae). Pan-Pacific Entomol. 19:148–153.

Khalaf, K. T. 1952. The *Culicoides* of the Wichita Refuge, Oklahoma. Taxonomy and seasonal incidence (Diptera, Heleidae). Ann. Entomol. Soc. Am. 45:348–358.

Khalaf, K. T. 1957. Light-trap survey of the *Culicoides* of Oklahoma (Diptera, Heleidae). Am. Midl. Nat. 58:182–221.

Kruger, E. L., L. G. Pappas and C. D. Pappas. 1990. Habitat and temporal partitioning in tree hole *Culicoides* (Diptera: Ceratopogonidae). J. Am. Mosq. Control Assoc. 6:390–393.

Pappas, C. D. and L. G. Pappas. 1989. *Culicoides* (Diptera: Ceratopogonidae) species in southeastern Nebraska. J. Am. Mosq. Control Assoc. 5:42–44.

Wirth, W. W., A. L. Dyce and B. V. Peterson. 1985. An atlas of wing photographs, with a summary of the numerical characters of the Nearctic species of *Culicoides* (Diptera: Ceratopogonidae). Contrib. Am. Entomol. Inst. (Ann Arbor) 22:1–46.

Wirth, W. W. and N. Marston. 1968. A method for mounting small insects on microscope slides in Canada balsam. Ann. Entomol. Soc. Am. 61:783–784.